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Research Article

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Effect of polyethylene mulch on soil temperature

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Summary

Field experiment framed in a Randomized Block Design was conducted to assess the impact of polyethylene mulch on soil temperature and yield of drip irrigated bitter gourd during 2015-16 in the Department of Irrigation and Drainage Engineering Dr. PDKV, Akola. The soil temperature at 15cm soil depth at 06:00 hrs was observed more than the ambient temperature, while at 14:00 hrs, it was less than ambient temperature, irrespective of irrigation scheduling treatments. The soil temperature under black mulch was observed to be highest followed by silver mulch, while temperature of soil without mulch cover was observed to be the lowest. Though average ambient temperature varied from 13 to 32.1^{0}C, the soil temperature under mulch varied from 22.4 to 27.8^{0}C *i.e.* in optimal temperature range for bitter gourd production. Subsequently, the crop yield was found maximum under black polyethylene mulch with irrigation scheduling at 80 per cent crop evapotranspiration through drip irrigation system followed by under silver mulch with irrigation scheduling at 80 per cent ETc.

Key words : Bitter gourd, Mulch, Drip irrigation, Soil temperature, WUE

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Introduction

Crop productivity enhanced with use of mulches (Jayasinghe and Goonasekera,1993; Tiwari *et al*., 2003 and Diaz-Perez, 2010). Mulching with drip irrigation system is an effective method of manipulating crop growing environment to increase yield and improve product quality by ameliorating soil temperature, conserving soil moisture, reducing soil erosion, improving soil structure and enhancing organic matter content (Rajablariani *et al.*, 2012 and Patil *et al*., 2013). Colour of mulch affects the micro-environment surrounding the plants.

Bitter gourd (*Momordica charantia* L.) is one of the most popular vegetable in South East Asia. It is a member of cucurbit family. The fruit of bitter gourd is similar in nutritional value compared to other cucurbits, along with much higher in folate and vitamin C content.

Plastic mulches directly affect the microclimate around the plants by modifying the radiation budget of the surface and decreasing the soil water loss (Liakatas *et al.*, 1986). Moreover, mulching avoids the deep fluctuations in temperature in the first 20–30 cm depth in soils. Such stable condition yields good root development and promoting faster crop development and earlier harvest. The soil temperature under plastic mulch depends on the thermal properties (reflectivity, absorptive or transmittance) of a particular material in relation to the incoming solar radiation (Schales and Sheldrake, 1963; Tripathi and Katiyar, 1984). Thus, there is need to study the impact of particular type of mulch on soil

temperature as a yield parameter.

Resource and Research Methods

The field experiment framed in RBD was conducted during 4th November 2015 to 21th February 2016 at research farm of Department of Irrigation and Drainage Engineering, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

Soil characteristics :

The soil characteristics at experimental site studied by Pawar (2014) was referred and presented in Table A.

Experimental detail :

The field experiment consists of nine treatments with three replications. The detail of treatments are given in Table B.

Soil temperature :

Temperature of soil was observed during the crop period of experiment with the help of thermometer already inserted in soil at 15 cm depth in all treatments (Fig. A). The soil temperature was recorded daily at 06:00 and 14:00 hrs.

Fig. A : Glass thermometer positioned in the soil

Water use efficiency :

Irrigation requirement of bitter gourd :

Water requirement of the bitter gourd under drip irrigation at 60 per cent, 80 per cent and 100 per cent replenishment of evapotranspiration was computed on daily basis based on pan evaporation by using following equation for treatments.

$$ET_c = E_p \times K_c \times K_p \qquad ......(1)$$

where, ET_c is crop evapotranspiration, mm day^{-1}, K_c is crop co-efficient, K_p is pan co-efficient and E_p is pan evaporation, mm day^{-1}.

Table A : Soil characteristics at experimental site

Soil horizon	Soil depth cm	Sand %	Silt %	Clay %	Textural class	Bulk density gcm^{-3}	Water retention at, cm^{3}cm^{-3}		Saturated moisture content, cm^3 cm^{-3}	K_s, cm day^{-1}
							0.33 bar	15 bar		
Ap	0-18	10.2	31	58.8	Clay	1.25	0.34	0.18	0.51	25.84
A	18-42	9.6	30.2	60.2	Clay	1.26	0.35	0.20	0.51	25.50
C	42-68	50.3	12.4	37.3	Sandy clay	1.35	0.26	0.15	0.40	11.48

Table B : Detail of treatments

Treatments	Specifications
T_1	60% ETc under silver polyethylene mulch
T_2	60% ETc under black polyethylene mulch
T_3	80% ETc under silver polyethylene mulch
T_4	80% ETc under black polyethylene mulch
T_5	100% ETc under silver polyethylene mulch
T_6	100% ETc under black polyethylene mulch
T_7	60% ETc without polyethylene mulch
T_8	80% ETc without polyethylene mulch
T_9	100% ETc without polyethylene mulch

The volume of water to be applied per treatment was calculated with following equation.

$$V = ET_c \times A \times N \qquad ......(2)$$

where, V is volume of water per treatment, lit; ET_c is crop evapotranspiration, mm day^{-1}; A is area of one plot, m^2 and N is the number of plots.

Water use efficiency :

The water use efficiency (WUE, Michael, 1979) was calculated for each treatment to check the response of bitter gourd to the individual treatment using following relationship.

$$WUE = \frac{\text{Total tomato yield, q}}{\text{Total water applied, ha – cm}} \qquad ......(3)$$

Research Findings and Discussion

Effect of polyethylene mulches (*i.e.* black and silver) on soil temperature and yield of crop under different irrigation treatments is discussed in the following sub-headings.

Effect of polyethylene mulches on soil temperature:

The variation of daily recorded soil temperature at 15 cm soil depth at 6:00 hrs and 14:00 hrs is depicted in Fig. 1, 2 and 3, whereas Fig. 4 shows treatment wise variation of average soil temperature.

It is seen from the Fig. 1, 2 and 3 that at 06:00 hrs, the soil temperature was more than the ambient temperature, while at 14:00 hrs it was less than ambient temperature. The similar pattern is seen in all cases of irrigation scheduling. The soil temperature under black mulch was observed to be highest followed by that under silver mulch, while temperature of soil without any mulch cover was seen to be the lowest.

It is seen from the Fig. 3 that at 06:00 hrs average

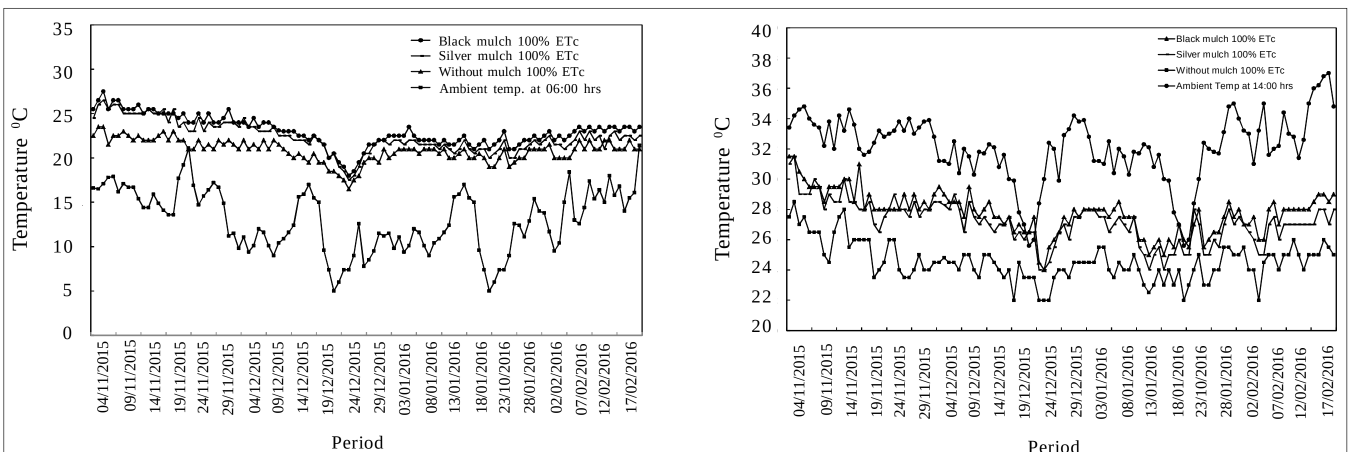

Fig. 1 : **Variation in soil temperature at 06:00 and 14:00 hrs for irrigation scheduling at 100 per cent ET_C**

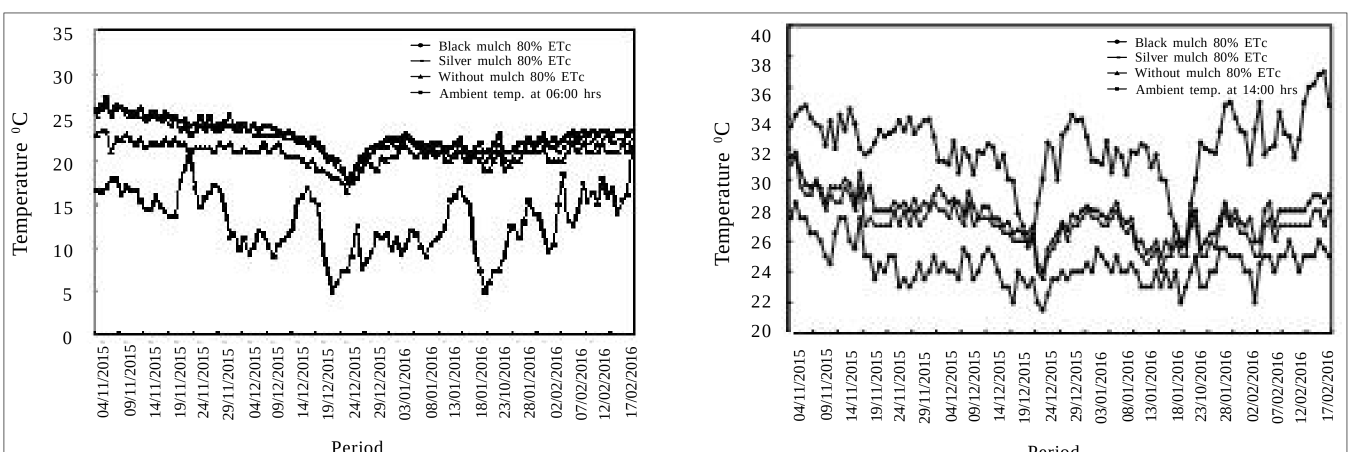

Fig. 2 : **Variation in soil temperature at 06:00 and 14:00 hrs for irrigation scheduling at 80 per cent ET_C**

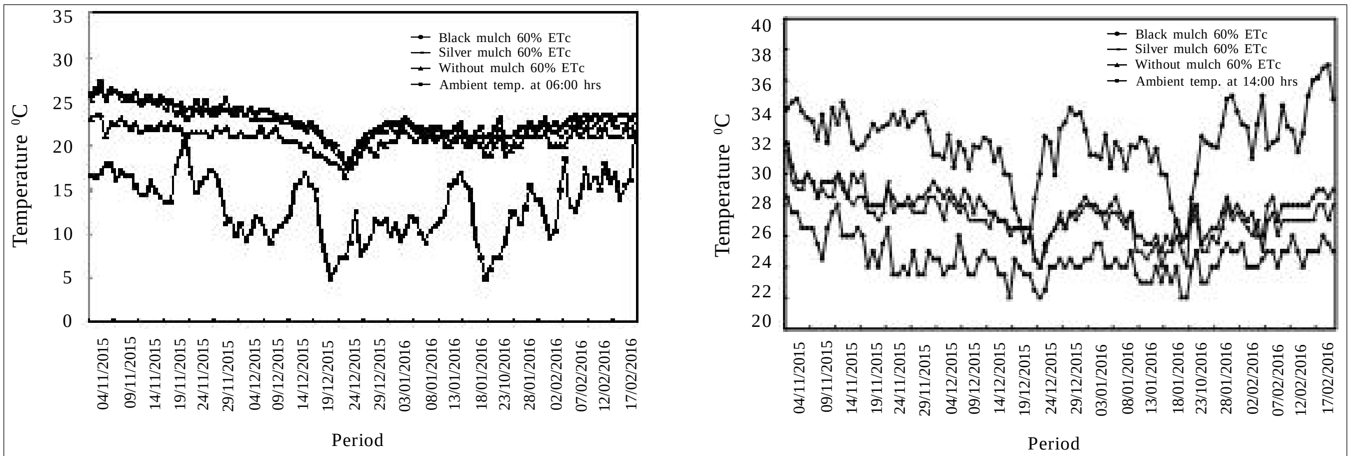

Fig. 3 : Variation in soil temperature at 06:00 and 14:00 hrs for irrigation scheduling at 60% ET_C

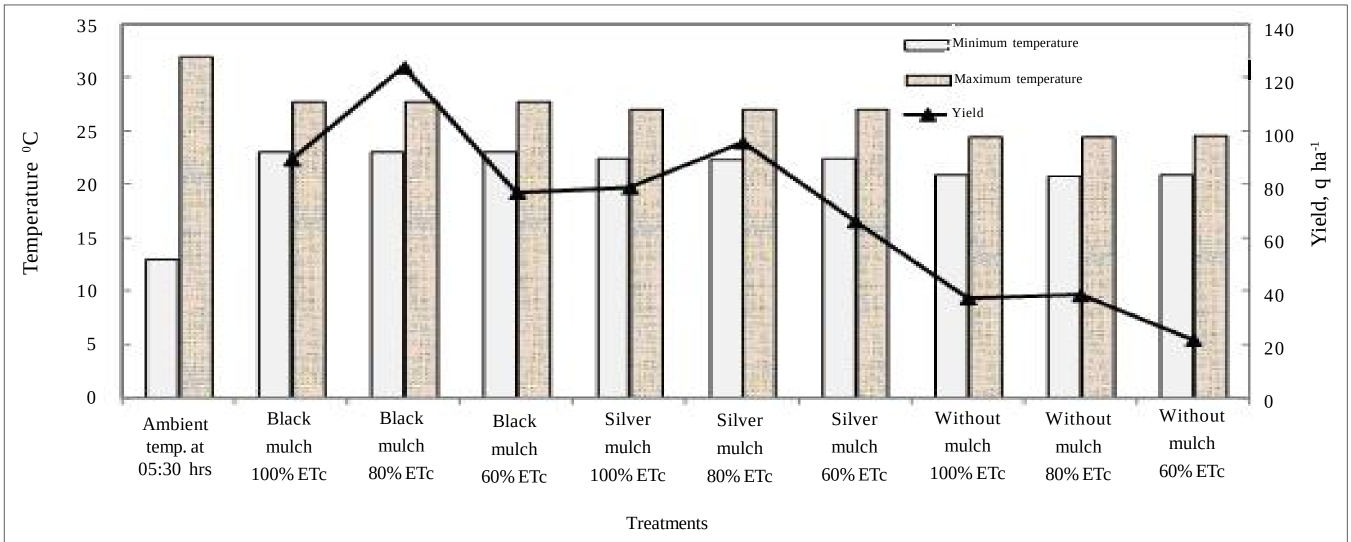

Fig. 4 : Variation in average soil temperature and yield

ambient temperature is too less *i.e.* 13°C, but average soil temperature was seen as varying between 20.8 to 23°C in different treatments. The average soil temperature at 06:00 hrs was highest under black mulch followed by that under silver mulch, while the lowest was seen for soil without mulch. It is seen from the Fig. 4 that at 14:00 hrs average

Table 1 : Water use efficiency

Treatments	Consumptive use/ha ha-cm	Yield /ha q	Water use efficiency q/ha-cm
T_1	24.88	66.08	2.66
T_2	24.88	76.94	3.09
T_3	31.43	95.68	3.04
T_4	31.43	123.98	3.94
T_5	37.97	78.65	2.07
T_6	37.97	89.27	2.35
T_7	24.88	21.63	0.87
T_8	31.43	38.45	1.22
T_9	37.97	38.67	1.02

ambient temperature is though high *i.e.* 32.1°C, but average soil temperature under different treatments was seen to be varying between 24.2 to 27.8°C. In general, average soil temperature increased compared to that at 6:00 hrs. The average soil temperature at 14:00 hrs followed the similar pattern as that at 06:00 hrs. It also confirmed that the mulch maintained the soil temperature between 22.4 to 27.8°C, irrespective of variation in average ambient temperature. Though average ambient temperature varied from 13 to 32.1°C (variation of 19.1°C), soil temperature under mulch varied from 22.4 to 27.8°C (only variation of 5.4°C). The soil temperature under mulch was maintained in optimal range (Palada and Chang, 2003) prescribed for bitter gourd production.

Water use efficiency :

Water use efficiency estimated for each treatment is presented in Table 1. It cleared from Table 1 that the treatment T_7 *i.e.* without polyethylene mulch with irrigation scheduling at 60 per cent crop evapotranspiration resulted in lowest water use efficiency, whereas the treatment T_4 (drip + black mulch, with irrigation scheduling @ 80% ETc) recorded highest water use efficiency followed by treatment T_2, T_3, T_1, T_6, T_5, T_8, T_9 and T_7. However, irrigation water applied in treatment T_3 and T_4 was same, but WUE was more for treatment T_4. It is due to higher bitter gourd yield recorded in treatment T_4 as compared to treatment T_3. It might be the effect of black polyethylene mulch that maintains the soil temperature in optimal range *i.e.* 24 to 27°C (Palada and Chang, 2003) which was reflected in the highest yield.

Inference :

The polyethylene mulch maintains soil temperature in optimal range required for bitter gourd production and thereby resulted in highest yield. Thus, it is suggested that the bitter gourd should be grown under black polyethylene mulch with drip irrigation at 80 per cent replenishment of crop evapotranspiration for higher water use efficiency.

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